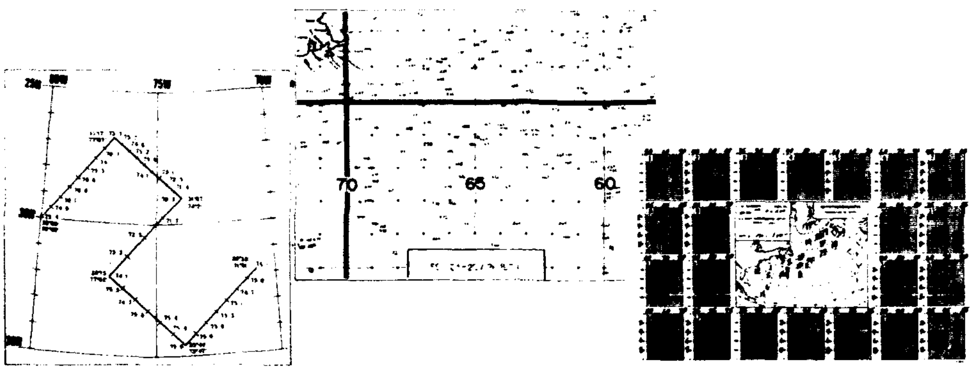
SP-103
ASWEPS MANUAL SERIES
VOLUME 3

DECODING AND PLOTTING



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ERRATA SHEET - H.O. SP-103

p. 6 Line 5 from bottom. read: 90°W to 180°.

p. 7 Line 17. Instead of $L_oL_oL_oL_o$, read $L_oL_oL_oL_oL_o$.

pp. 11 & 12 Paragraph 2.4.2. Delete entire section. The code presented will not be used. The code is being modified, and an addendum sheet will be issued when the revision is completed.

p. 30 Line 9 from bottom. Instead of Figure 5, read Figure 4.

SP-103

ASWEPS MANUAL

VOLUME 3

DECODING AND PLOTTING

By

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CHAPTER 1. INTRODUCTION

1.1 GENERAL. This volume discusses procedures used in the first stage of the data reduction process, after oceanographic observations have been transmitted from the collection points. Within the context of this stage, consideration is given to observations as they are: (a) received; (b) decoded; (c) checked for errors; and (d) plotted in suitable form for the analyst. Data are received by radio or teletype from diverse sources: ships, helicopters, aircraft, and fixed platforms. The instruments used for data collection are varied and the form in which the data are received will depend on the parameter being measured (sea surface temperature, subsurface temperature, wave height, etc.), and the instrument used (injection thermometer, airborne radiation thermometer, bathythermograph, etc.). In addition to raw data reports, environmental technicians at Patrol Squadron (VP) bases and at sea will receive already analyzed charts from central processing activities. However, these will be regional, large-area presentations which will require modification and updating with locally collected data. Two forms of analyzed charts may be received: (1) a hand-drawn analysis and (2) a computerized analysis. These analyses will be received over the radio facsimile broadcast or a high speed data link. Computerized products for all oceans will originate primarily from the Fleet Numerical Weather Facility (FNWF) in Monterey, California. Western North Atlantic coverage by radio facsimile will be provided by the Fleet Weather Facility in Norfolk, Virginia (FWF, NORVA) and the U.S. Naval Oceanographic Office, Washington, D.C. (NAVOCEANO). Eastern Atlantic and the Mediterranean operating areas will be covered from Fleet Weather Central (FWC), Rota, Spain. Eastern North Pacific coverage will originate from FWC, Alameda, California; Mid-Pacific coverage from FWC, Pearl Harbor; and Western Pacific coverage from FWC, Guam.

1.2 UNPROCESSED OCEANOGRAPHIC OBSERVATIONS. Raw oceanographic observations are received by routine weather sequences (4, 5, 7, 8) and by special messages in prescribed formats (1, 6). Synoptic weather reports received by teletype or radio service over direct weather circuits are the prime sources for sea surface temperature (SST) and wave height observations. Other types of oceanographic observations are obtained by various instruments from surface and airborne platforms and encoded in specially designed ASWEPS formats as follows: airborne radiation thermometer data, code ARTST; bathythermograph data, code BATHY; additional sea surface temperature observations from Navy and other selected ships, code CTEM; and subsurface temperature and salinity observations, code OCEAN. As additional instrumentation is developed to improve the data input to ASWEPS, code changes and/or new codes required will be issued as appendixes to this manual.

1.3 ANALYZED DATA. Regional analyses provide a "first look" at the

synoptic or forecasted oceanographic condition of interest. Although valuable for planning purposes, they cannot include the type of local detail in which a specific operational command is interested. The ability to receive the regional analysis from a remote processing activity, however, eliminates much duplication and attendant data handling at the receiving end, since in many instances, all that will be required is updating with locally obtained data and a reanalysis of the operating area within the limits indicated by the regional picture.

1.3.1 COMPUTER PROCESSED DATA. Computer processed oceanographic data are transmitted over selected oceanographic circuits. Data values for different oceanographic parameters are printed out in a scaled format on a CALCOMP 770 incremental plotter. The print-out is arranged to fit a 1:30,000,000 polar stereographic chart true at 60° North Latitude. This type of data is available only at the Regional Analysis Centers. Parameters, analyses, and prognostic charts available are discussed in ASWEPS Manual Volume 9, "Numerical Techniques".

1.3.2 REGIONAL ANALYSIS CENTERS. Oceanographic observations received from all sources are plotted and analyzed at the appropriate components of the Naval Weather Service and at NAVOCEANO. Analyses and prognostic charts, mostly hand-drawn, are disseminated by radio facsimile and may be received at the land stations or aboard properly equipped ships. Charts transmitted are polar stereographic projections (1:7,500,000) and present analyses of the individual parameters for various ocean areas.

1.4 LOCALLY APPLIED DATA. Updating and modifying regional analyses for local application will be carried out primarily at the weather offices supporting operational commands: Fleet Air Wings (FAIRWING) and Task Groups. Both groups are collectors as well as users of oceanographic data so attached ASWEPS personnel will have access to the data collected by the group components prior to its transmission to a regional processing center. In most cases the applicable portion of the regional analysis should be transcribed onto a new base and the locally collected data added so that a more detailed analysis can be made for the area of interest. Environmental technicians at FAIRWING Commands will use these detailed analyses for briefing flight crews of ASW aircraft on expected oceanographic conditions in their patrol areas. Shipboard forecasters will use the detailed analyses both as briefing aids and inputs for sonar range predictions.

CHAPTER 2. DATA CODES

2.1 INTRODUCTION. Synoptic oceanographic observations are normally coded into the prescribed format by the observer or one of the ship's officers for transmission to a processing center. Environmental technicians assigned to shipboard forecasting units and FAIRWING Commands, however, will code the data messages forwarded by their commands, as well as decode those received from others. The following sections describe the different codes and transmission formats with which the environmental technician must be familiar if he is to code and/or decode the data correctly.

2.2 SYNOPTIC WEATHER SEQUENCE CODE. The primary source for sea surface temperature and wave data is the synoptic weather sequence, code FM 21.C (4, 5, 8). Sea temperature is not, however, reported directly, but must be derived from the air temperature and the air-sea temperature difference. A ship making an FM 21.C surface report utilizes the following format:

SHIP $\underline{YQL_aL_aL_a}$ $\underline{L_oL_oL_oGC}$ Nddff VVwwW $PPP\underline{TT}$

$N_hC_LC_MC_H$ D_sv_sapp (7RRjj) $(8N_sCh_sh_s)$ $(9S_pS_pS_pS_p)$

$(O\underline{T_sT_s}T_dT_d)$ $(1\underline{d_wd_w}P_wH_w)$ $(2I_sE_sE_sR_s$ or ICING) ICE. . .

Only the above underlined characters are used in constructing *ASWEPS charts*. Each of these is referred to below and explained for decoding and plotting purposes:

$\underline{YQL_aL_aL_a}$

Y — Day of the Week

Code Figure	Code Figure
1 Sunday	5 Thursday
2 Monday	6 Friday
3 Tuesday	7 Saturday
4 Wednesday	

Q — Octant of the globe

Northern Hemisphere — Southern Hemisphere

Code	Longitude	Code
0	0° to 90°W	5
1	90°W to 180°	6
2	180° to 90°E	7
3	90°E to 0°	8

$L_aL_aL_a$ — Latitude in tenths of degrees. Minutes are obtained by multiplying the number of tenths by 6.

$\underline{L_oL_oL_oGG}$

$L_oL_oL_o$ — Longitude in tenths of degrees. The hundreds digit is omitted for longitudes 100° to 180°. Check octant column for correct hundreds value and hemisphere. For octant 1, 2, 6, and 7 add 100 to degrees. (See Q above.)

GG — Greenwich Time in whole hours.

PPP$\underline{TT}$

TT — Air temperature in whole degrees centigrade or Fahrenheit. Temperatures are read in tenths of degrees centigrade or in fifths of degrees Fahrenheit and rounded subsequently to the nearest whole degree. For negative temperatures in degrees centigrade, 50 is added to the absolute value of the temperature. Thus, a temperature of -TT°C is given by (50+TT); the hundreds figure, if any, is omitted. A temperature of -50°C is given as 00. The distinction between -50°C and 0°C is made from the general weather situation and from comparison with previous reports of the same station. For negative temperatures in degrees Fahrenheit, 100 is added algebraically; thus a temperature of -TT°F is given by (100 - TT).

$O\underline{T_sT_s}T_dT_d$

T_sT_s — Difference between air temperature and sea temperature in half-degrees centigrade (3.5° = 7 half-degrees) or whole degrees Fahrenheit. If the air temperature is below the sea temperature, 50 is added to the numerical value of the difference for coding the report; e.g., if the air temperature is 17.5°C below sea temperature, T_sT_s is coded as 85 (17.5 X 2 + 50). The same method is used for degrees centigrade and Fahrenheit; e.g., if the air temperature is 17°F below the sea temperature, the coded value is 67.

$(1d_w d_w P_w H_w)$ Optional group for reporting wave direction, period, and height. A complete explanation is given in Section 3.3 following.

The complete FM 21.C code is discussed fully in References 4, 5, 7, and 8.

2.2.1 COMPUTING SST WHEN $TT > T_sT_s$.

(1) Given:

$TT = 77$
$T_sT_s = 02$
$TT - T_sT_s = °F$
$77 - 2 = 75°F$

(2) Given:

$TT = 17$
$T_sT_s = 04$
$TT - T_sT_s = °C$
$17 - 4/2 = 17 - 2 = 15°C$

2.2.2 COMPUTING SST WHEN $TT < T_sT_s$.

(1) Given:

$TT = 57$
$T_sT_s = 64$
$TT + (T_sT_s - 50) = °F$
$57 + (64 - 50) = 57 + 14 = 71°F$

(2) Given:

$TT = 26$
$T_sT_s = 57$
$TT + (T_sT_s - 50) = °C$

$$26 + \frac{(57 - 50)}{2} = 26 + \frac{7}{2} = 26 + 3.5 = 29.5°C$$

2.3 SPECIAL SEA SURFACE TEMPERATURE CODES. Fleet and selected Military Sea Transportation Service (MSTS) and Coast Guard ships measure sea surface temperature more frequently for ASWEPS than is required for standard synoptic weather reporting. Some of these ships are equipped with improved instrumentation, which replaces the injection thermometer. Aircraft flying the airborne radiation thermometer (ART) also report surface temperature observations without respect to standard synoptic times. Regardless of the sensor, however, data are transmitted in a consistent format. Although two codes are used, one by ships and the other by aircraft, the method of presentation varies only in the number of position and temperature groups reported.

2.3.1 CTEM CODE. Ships report in the CTEM code. Sea surface temperature

observations taken twelve (12) times daily on the odd hours are transmitted at the end of each day as a collective. The sensor is identified by a coded entry. The CTEM code is as follows:

$CTEMI_r$ DDMMY $QL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $GGT_rT_rT_r$ 19991

$CTEMI_r$	Code prefix and instrument identifier group.
CTEM	Code prefix indicating that sea surface temperature data are to follow.
I_r	The specific device with which the observation was made is coded as follows: 2 - Injection Thermistor (NSRT) 3 - Bucket Thermometer 4 - Injection Thermometer 5 - Other device
DDMMY	
DD	Day of month that observation was made with reference to Greenwich Mean Time. The first day is coded as 01, the seventeenth day as 17, etc..
MM	Month of year. January is coded as 01, November is coded 11, etc..
Y	Last digit of year. The year 1965 is coded as 5, 1957 as 7, etc..
$QL_aL_aL_aL_a$	
Q	Octant of globe where observation was made. Code as follows:

Northern Hemisphere Southern Hemisphere

Code	Longitude	Code
0	0° to 90°W	5
1	90° to 180°	6
2	180° to 90°E	7
3	90°E to 0°	8

$L_aL_aL_aL_a$	Latitude in tens and units of degrees and tens and units of minutes.

$L_oL_oL_oL_oL_o$	Longitude in hundreds, tens, and units of degrees and tens and units of minutes.
$GGT_rT_rT_r$	
GG	Time of observation in whole hours (Greenwich Mean Time).
$T_rT_rT_r$	Sea surface temperature to the nearest 0.1°C.
19991	End of message indicator.

2.3.2 ARTST CODE. The ARTST code is used to transmit sea surface temperature measurements taken by airborne radiation thermometers (ART), which are mounted on ASW patrol aircraft. With this combination of platform and instrument, a large geographical area can be surveyed in a relatively short time, and the measurements considered quasi-synoptic. Although the instrument records continuously, the message can reflect only selected points along the flight path. Observations are reported at either 2- or 4-minute intervals. All values should be plotted. The code follows:

ARTST DDMMY $QL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ GGgg $T_rT_rT_r$ $T_rT_rT_r$

. . . $QL_aL_aL_aL_a$ $L_oL_oL_oL_o$ GGgg $T_rT_rT_r$ $T_rT_rT_r$ . . .

$QL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ GGgg 19991.

ARTST is the indicator group; the next three groups are identical to the CTEM code. Time is reported to nearest minute (gg) in order to fix the speed of the aircraft between reported positions. Each change in heading is indicated by a new position and time. The interval of observation can be ascertained by dividing the time difference by the number of temperature values reported between two consecutive headings. Environmental technicians at air bases will be dealing primarily with observations of 4-minute intervals; those aboard ship will be dealing with 2-minute observations; those at Regional Analysis Centers will be dealing with both types. Temperatures are reported to a tenth of a degree centigrade.

2.3.2.1 DECODING ARTST MESSAGES. The body of the ARTST message begins with the position followed by the temperature. Decoding begins with plotting the latitude and longitude for the first line of data. Next, latitude and longitude for the second line of data are plotted. Draw a straight line connecting the two positions. This is the aircraft track for the first leg. Count the number of temperature observations following the position and time of the

first line of data. Divide the track into an equivalent number of spaces. Beginning at the first position, plot the temperature at each point dividing the flight leg into spaces. The temperature for the final point on the leg, or the turning point, is given as the first observation on the second leg. Continue with the third position to obtain the flight leg; divide into the appropriate number of segments corresponding to the number of observations taken on this leg; and proceed as before. The last line of the message contains only the terminal time and sea temperature value for the sole position which terminates the last segment of the flight. Each message concludes with 19991, the end of message indicator. Figure 1 is a reconstruction of the ART message given below.

ARTST 23045 03000 08000 1200 754 749 761 766 766 753 753
707 03317 07707 1307 735 757 746 752 750 747 731 725 714
03107 07421 703 717 725 739 02815 07702 1427 751 753 747
758 754 ·754 02544 07347 1547 750 750 756 753 751 747 750
02828 07101 1711 751 19991.

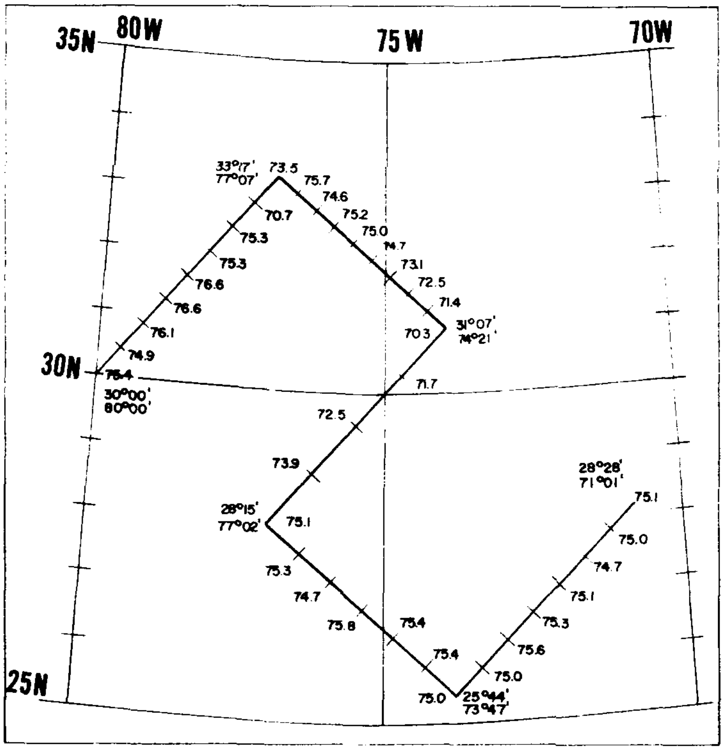


FIGURE 1

A Plotted ARTST Report

2.4 SUBSURFACE DATA CODES. Subsurface oceanographic observations are obtained with a variety of instruments but the basic codes used for radio and teletype transmission are essentially the same. The BATHY code provides for temperature and depth data only and is the most widely used. The OCEAN code is also used to transmit temperature with depth data, but includes provisions for reporting salinity and sound velocity with depth as well.

2.4.1 BATHY CODE. All bathythermograph (BT) observations, whatever their source, are reported in the BATHY code. Naval vessels are required to obtain and transmit four BT observations each day at standard

synoptic times. In addition, BATHY messages are received from cooperating governmental agencies, educational institutions, selected commerical companies, and foreign navies and agencies. The code accomodates shipboard reports in either English (Fahrenheit and feet) or metric (centigrade and meters) units. The only basic change occurs in reports of airborne expendable bathythermographs, when "88888" replaces "BATHY" as the message prefix indicator. The BATHY code is:

BATHY YGGgg $QL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $\underline{I_rI_rT_rT_rT_r}$ $ZZT_oT_oT_o$

$ZZT_zT_zT_z$ . . . Repeated as many times as necessary to present data . . .

19991.

The first three groups following the message indicator are identical to groups explained in paragraphs 2.3.1 and 2.3.2. The fourth group (underlined above) is the reference temperature group which is used to supplement the surface temperature data. Explanation of the data groups follows:

$I_rI_rT_rT_rT_r$ Reference Temperature Group.

I_rI_r Instrument Indicator.

Coded entry for type of instrument utilized to obtain the reference temperature.

Code		Instrument
XX	(°F)	Bucket Thermometer
YY	(°C)	Bucket Thermometer
99	(°F)	Injection Thermometer
98	(°C)	Injection Thermometer
89	(°F)	Injection Thermistor (NSRT)
88	(°C)	Injection Thermistor (NSRT)

$T_rT_rT_r$ Reference temperature.

The near surface sea water temperature, reported in degrees and tenths. For temperature values below 0°C, 50.0 is added to the value. To decode, subtract 50.0 from the value transmitted. (NOTE: If only injection temperatures are available and readable only to the nearest whole degrees, the entry for the reference temperature would be reported to the nearest whole degree with 0 (zero)

used to indicate the tenth of degree value.)

$ZZT_oT_oT_o$ — Surface Temperature Group.

ZZ — Depth indicator at the sea surface. Coded as "00" (zero zero).

$T_oT_oT_o$ — Sea temperature in degrees and tenths at the surface as recorded by the bathythermograph. Subtract 50.0 to decode negative centigrade values.

$ZZT_zT_zT_z$ — Depth-Temperature Group. This group is repeated as necessary to describe the BT trace. Either English or metric units may be received, as follows:

$ZZT_zT_zT_z$ REPORTED IN ENGLISH UNITS (ft., °F):

ZZ — Depth of water, reported in tens of feet, at which corresponding temperature was read from the BT trace. (Ex: 50 ft. = 05; 150 ft. = 15.)

$T_zT_zT_z$ — Subsurface temperature at depth ZZ in degrees and tenths Fahrenheit reported for as many depths as are necessary to describe the BT trace.

99999 — 1,000-foot Indicator Group. A mandatory group used to indicate that the depth/temperature groups following are at and below the 1,000-foot level.

$ZZT_zT_zT_z$ — Depth-Temperature Group.

ZZ — Depths at and below 1,000 feet are reported using the second and third digits. (Ex: 1020 ft. = 02; 1470 ft. = 47.)

$T_zT_zT_z$ — Water temperature in degrees and tenths Fahrenheit at ZZ.

19991 — End of message indicator group.

$ZZT_zT_zT_z$ REPORTED IN METRIC UNITS (m., °C):

ZZ — Depth of water, in meters, at which the

corresponding temperature was read from the BT trace. (Ex: 5m = 05; 99m = 99.)

$T_zT_zT_z$ — Water temperature at the corresponding depth, reported in degrees and tenths centigrade. For temperature values below 0°C, 50.0 is added to the value. This group is repeated as necessary to describe the BT trace between the surface and 99 meters.

$Z_nZ_nT_oT_oT_o$ — 100-Meter Level Indicator.

Z_nZ_n — The 100-meter level is coded 00.

$T_oT_oT_o$ — Water temperature at 100 meters, in degrees and tenths.

$ZZT_zT_zT_z$ — Depth-Temperature Group, 101 to 199 Meters.

$Z_nZ_nT_oT_oT_o$ is inserted for each successive 100-meter level reported. Z_nZ_n is coded as 00 in every case.

$ZZT_zT_zT_z$ is repeated as many times as necessary to reproduce the trace between the 100-meter intervals.

The appearance of 00 depth in the body of the message is one signal that metric units are being used and eliminates the need for 6 digit groups while still reporting to the nearest meter.

19991 — End of Message Indicator Group.

2.4.2 OCEAN CODE. Selected vessels are being equipped with the Salinity-Temperature-Depth (STD) Sensor which measures temperature (T) and salinity (S) to 1500 meters depth (D). Occasionally reports will also be received from research vessels carrying a modified STD which measures sound velocity (V) in addition to salinity and temperature. The OCEAN code is used to transmit these data. The OCEAN code is:

OCEAN YGGgg $QL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $(1d_wd_wP_wH_w)$ $I_rI_rT_rT_rT_r$

11111 $Z_oZ_oT_oT_oT_o$ $Z_zZ_zT_zT_zT_z$ --- (repeated) 33333 $Z_oZ_oS_oS_oS_o$

$Z_zZ_zS_zS_zS_z$ --- (repeated) 55555 $Z_oZ_oV_oV_oV_o$ $Z_zZ_zV_zV_zV_z$ --- (repeated)

19991

Groups 1 through 5 following the message indicator represent the same elements previously defined (paragraphs 2.2, 2.3, 2.4). The group "11111" indicates that temperature/depth data follow, beginning with the value recorded at the surface ($Z_oZ_o = 00$). "33333" indicates salinity/depth data to follow; "55555" indicates sound velocity/depth data. The message should include as many subsurface groups for each parameter as are required to reconstruct the instrument record. The group "19991" is the end of message indicator. Temperature is reported to a tenth of a degree centigrade; salinity to the nearest five hundredth of a part per thousand; and sound velocity to a tenth of a meter per second. The first (tens) digit of salinity, and the first two (thousands and hundreds) digits of sound velocity are not transmitted. Depths are reported to the nearest ten meters. Zero (0) will prefix any depth less than 100 meters. Thus a salinity of 34.90 at 50 meters will be reported as 05490; a sound velocity of 1498.2 at 200 meters will be reported as 20982. When plotting sea surface temperature from OCEAN messages, the reference temperature is preferred to the sensor temperature reading at the surface.

CHAPTER 3. PLOTTING SURFACE DATA

3.1 SEA SURFACE TEMPERATURE CHART. Because sea surface temperatures are the most abundant of oceanographic data, the SST analysis is used as a guide to analyze less frequently measured subsurface features. This is perhaps its most important role, but it also provides a direct input to all ASWEPS forecasts and to longrange sonar and fog predictions. Therefore it is extremely important that the SST data be as accurate and be plotted as precisely as possible, since erroneous values and incorrect positioning of correct values can change the entire character not only of the SST analysis but of all the other resultant products.

3.1.1 PLOTTING MODEL. A single day's collective of data reports is seldom sufficient to prepare a regional analysis. Consequently, the composite chart, an accumulation of several days' data plotted on the same base, is a common tool used by analysts for general guidance. The exact number of days in a composite will vary, since it depends on many factors: the size of the area, the average number of reports received daily, and the variability of the environment in the area, the latter being the most important. The ten-day composite, usually the greatest compilation of data required for analysis, illustrates the general method to be followed in constructing any composite chart. In order to subdivide the total time interval and preserve continuity, composite charts are constructed on an overlapping basis. Each chart consists of two basic elements: for the ten-day chart, the first is a compilation of the data from the preceding five days; the second, the addition of data on a daily basis for the succeeding five days. On the eleventh day, the initial five days are dropped, the most recent five days' data are replotted on a new base, and the next five days plotted on a daily basis as before.

3.1.2 LATITUDE AND LONGITUDE CONVERSION. Code FM 21.C provides for reporting latitude and longitude in degrees and tenths of degrees. To facilitate plotting it may be desirable to convert tenths into minutes. Table I is provided for this purpose.

TABLE 1
Conversion of Tenths of Degrees into Minutes

Tenths of Degrees	Minutes
0	00 to 05
1	06 to 11
2	12 to 17
3	18 to 23
4	24 to 29
5	30 to 35
6	36 to 41
7	42 to 47
8	48 to 53
9	54 to 59

3.1.3 TEMPERATURE CONVERSION. Although most temperatures are observed, recorded, and transmitted in degrees centigrade (Celsius), they are analyzed in degrees Fahrenheit. As the analyst usually must enter all sonar ranging tables currently in use with Fahrenheit and English units for distance (feet and kiloyards), temperatures are converted from centigrade for plotting. Table 2 below converts centigrade to Fahrenheit.

TABLE 2

Temperature Conversion

Degrees		Degrees		Degrees	
Centigrade	Fahrenheit	Centigrade	Fahrenheit	Centigrade	Fahrenheit
-02.5	28	10.0	50	22.5	73
-02.0	28	10.5	51	23.0	73
-01.5	29	11.0	52	23.5	74
-01.0	30	11.5	53	24.0	75
-00.5	31	12.0	54	24.5	76
±00.0	32	12.5	55	25.0	77
+00.5	33	13.0	55	25.5	78
01.0	34	13.5	56	26.0	79
01.5	35	14.0	57	26.5	80
02.0	36	14.5	58	27.0	81
02.5	37	15.0	59	27.5	81
03.0	37	15.5	60	28.0	82
03.5	38	16.0	61	28.5	83
04.0	39	16.5	62	29.0	84
04.5	40	17.0	63	29.5	85
05.0	41	17.5	63	30.0	86
05.5	42	18.0	64	30.5	87
06.0	43	18.5	65	31.0	88
06.5	44	19.0	66	31.5	89
07.0	45	19.5	67	32.0	90
07.5	45	20.0	68	32.5	91
08.0	46	20.5	69	33.0	91
08.5	47	21.0	70	33.5	92
09.0	48	21.5	71	34.0	93
09.5	49	22.0	72	34.5	94
				35.0	95

3.1.4 PLOTTING SYMBOLS. To conserve space and provide visual aid in data analysis, the day symbols and color codes given in Table 3 are employed for composite plotting. The time of observation rather than the date-time group of the message determines the correct symbol and chart base.

TABLE 3

SST Composite Chart Plotting Code

Day	Symbol	Color	Temperature (°F)
1st through 5th	.	Purple	<30
6th	-	Blue	30-39
7th	Δ	Green	40-49
8th	∇	Black	50-59
9th	+	Red	60-69
10th	x	Purple	70-79
		Blue	80-89
		Green	>90

Each observation is located geographically and plotted by day symbol and color code. Data are plotted using only the units and tenths digits. The color code identifies the tens value.

Example 1.

57.3°F for the 4th day is plotted in black as •7.3

Example 2.

74°F for the 7th day is plotted in purple as Δ 4

The last five days' data of a composite chart are transcribed to the succeeding chart using the dot (·) symbol. Data received over the next five days are plotted daily using the symbols for days 6 through 10. For example, the last five days' data for the chart 11 - 20 November (16 through 20 November) are transferred to the 16 - 25 November chart using dot symbols. The data indicators show daily variations of sea surface temperature. The color code aids the plotter in screening out gross data errors and helps the analyst by visually minimizing data congestion. A plotted sea surface temperature chart is depicted in Figure 2. (Other examples of plotted charts are portrayed in Reference 2.)

3.2 ERROR CHECKS. Many errors in the transmitted messages can be corrected by the plotter. Erroneous values are generally the result of encoding errors or transmission garbles. When plotted on the chart, all questionable entries are underlined once, corrected entries twice.

3.2.1 POSITION ERRORS. The correct geographic location is particularly

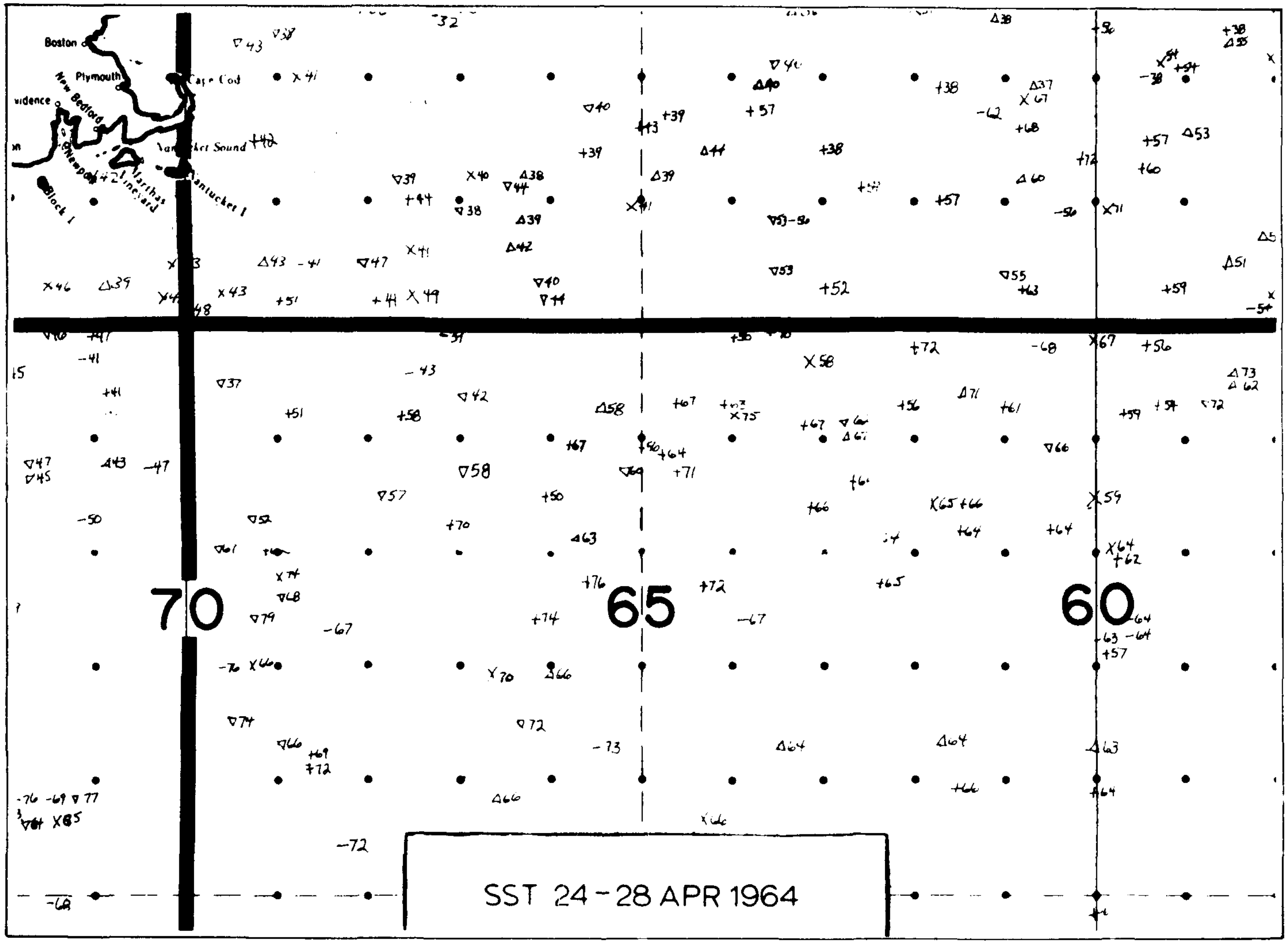


FIGURE 2

Plotted Composite Sea Surface Temperature Chart

important in plotting. When the octant is questionable, the correct octant may usually be ascertained by reference to previous messages transmitted by the ship. These messages can be plotted geographically to determine the ship's track and correct location. One frequent error is reversal of the latitude and longitude entries. A check of the air (TT in whole degrees centigrade or Fahrenheit) or sea temperature is useful in spotting this error. Another often repeated error is transmission of either latitude or longitude at a 10° interval below or above the correct value. Occasionally a 5° error also is made in reporting these values. Such errors can be corrected by reference to the ship's previous and following reports. Sea and air temperature values not compatible with surrounding values are also valuable indicators of erroneous position reports.

3.2.2 CODE FM 21.C. In code FM 21.C the longitude and time are often reversed. These message errors can be detected when the sea temperature at that position is not compatible with sea surface temperature in the surrounding vicinity or with the last reported position. They also can be detected if time as reported exceeds 24 hours.

3.2.2.1 SEA WATER TEMPERATURE. Frequently the sea water temperature is reported in whole degrees Fahrenheit in the air-sea difference columns. Although this value is an error in encoding, when it is recognized as such, the figures can be plotted directly.

3.2.2.2 AIR TEMPERATURE. Incorrect air temperature values are often received. Comparison of these values with those from corresponding latitudes will disclose gross errors. Recognized obvious mistakes may be checked by comparison with the dew point temperature (T_dT_d recorded in whole degrees centigrade or Fahrenheit) which cannot be a higher value than the air temperature. Gross errors of the ten digit order will be immediately apparent, but only experience can provide the plotter with knowledge to make lesser corrections. As incorrect values can alter the entire character of the analysis, the plotter must exercise extreme caution in changing values believed to be erroneous. An analyst should be consulted before the correction is made, and all changed data values should be doubly underlined when plotted.

3.2.3 BATHY REPORTS. Utilizing the sea reference temperature transmitted in BATHY messages presents a problem if the reference temperature varies significantly from the surface temperature recorded by the instrument. If these temperatures differ more than 2.5°F (1.5°C), special screening is required. Bucket thermometer and thermistor reports are usually accurate but injection readings are less reliable. Although reference temperatures are preferred for plotting, in cases where the 2.5° range is exceeded, the reliability of the BT surface temperature should be correlated with the position report and recent synoptic analyses to determine which value, if either, is to

be used. Consult the analyst before plotting either value and underline the value once.

3.2.4 AIRCRAFT REPORTS (ARTST). Airborne Radiation Thermometer (ART) data should be screened carefully for position. These temperatures are recorded continuously by the ART along the flight path of the aircraft. Location of each observation is calculated by dividing the track into even increments rather than from individual position reports. The length of the track is divided to correspond to the number of observations reported in order to determine the position for plotting. When the positions in the message are not compatible, the track of the airplane may be plotted completely to aid in the determination of a more definitive and realistic track. When in doubt, consult the analyst before discarding the reports.

3.3 SYNOPTIC WAVE CHART. The state of the sea is of utmost importance in the preparation of ASWEPS charts as it denotes ship behavior and sonar-quenching characteristics which are of prime interest in ASW operations. Synoptic Wave Charts are plotted daily utilizing data reported over radio and teletype. The primary source of data is the routine synoptic ship weather sequence (FM 21.C) received four times daily.

3.3.1 SYNOPTIC WAVE GROUP. The ship surface report in full form is discussed in paragraph 2.2. Data to locate the observation in time and space on the synoptic wave chart are obtained directly from the first and second groups of the message. There are seven mandatory groups in FM 21.C. In addition, there are five dropout groups enclosed in parentheses, each of which is provided with an indicator figure. These groups may or may not be reported depending on specified conditions. In ordinary ship weather sequences the wave group is always prefixed by the numeral "1" and is generally the ninth group.

3.3.2 EXPLANATION OF WAVE GROUP ($1d_Wd_WP_WH_W$). When it is possible to make a clear distinction between sea and swell, at least two $1d_Wd_WP_WH_W$ groups are included. The first group relates to wind waves, the second to waves of the predominant swell system. Swell systems other than the predominant one may be included in the report by additional $1d_Wd_WP_WH_W$ groups. In a case of "no sea" and "with swell", the first group is read 100X0.

3.3.2.1 WAVE DIRECTION. The two digits "d_Wd_W" following the wave group indicator give the direction, in tens of degrees, from which the waves are coming. The direction code is given by Table 4. All directions are referred to True North.

3.3.2.2 WAVE PERIOD. The fourth digit of the wave group, P_W, is the

TABLE 4

Wave Direction Indicator Code

Code Figure	Direction or Description	Code Figure	Direction or Description
00	Calm (no waves)	22	215° - 224°
01	5° - 14°	23	225° - 234°
02	15° - 24°	24	235° - 244°
03	25° - 34°	25	245° - 254°
04	35° - 44°	26	255° - 264°
05	45° - 54°	27	265° - 274°
06	55° - 64°	28	275° - 284°
07	65° - 74°	29	285° - 294
08	75° - 84°	30	295° - 304°
09	85° - 94°	31	305° - 314°
10	95° - 104°	32	315° - 324°
11	105° - 114°	33	325° - 334°
12	115° - 124°	34	335° - 344°
13	125° - 134°	35	345° - 354°
14	135° - 144°	36	355° - 4°
15	145° - 154°		
16	155° - 164°	49	Waves confused, direction indeterminate (waves equal to or less than 15 feet)
17	165° - 174°		
18	175° - 184°		
19	185° - 194°		
20	195° - 204°		
21	205° - 214°	99	Waves confused, direction indeterminate (waves greater than 15 feet)

wave period. Wave period is defined as the time required for two successive wave crests to pass through a fixed point, and is equal to the wave length (λ) divided by the wave velocity (v):

$$P_W = \frac{\lambda}{v}$$

The average value of the wave period is reported as obtained from the larger, well-formed waves of the wave system being observed. The code is given by Table 5. To decode, double the code figure.

TABLE 5

Period of Waves (P_w)

Code Figure	Period	Plot	Code Figure	Period	Plot
2	5 seconds or less	<5	8	16 or 17 seconds	16
3	6 or 7 seconds	6	9	18 or 19 seconds	18
4	8 or 9 seconds	8	0	20 or 21 seconds	20
5	10 or 11 seconds	10	1	Over 21 seconds	>21
6	12 or 13 seconds	12	X	Calm	00
7	14 or 15 seconds	14	X	Period not determined	XX

3.3.2.3 WAVE HEIGHTS. The fifth (and final) digit of the group is H_w, the wave height, defined as the vertical distance, in feet, between trough and crest. The wave height reported is the average value obtained from the larger well-formed waves of the wave train being observed. Table 6 shows the wave height code.

TABLE 6

Height of the Waves (H_w)

Code Figure	Height (ft) Plot	Code Figure	Height (ft) If 50 is added to $d_w d_w$ Plot
0	<1	0	16
1	1-1/2	1	17-1/2
2	3	2	19
3	5	3	21
4	6-1/2	4	22-1/2
5	8	5	24
6	9-1/2	6	25-1/2
7	11	7	27
8	13	8	29
9	14-1/2	9	30-1/2
X	X (Height not determined)		

Note 1.

If a wave height comes exactly midway between the heights corresponding to two codes values, the lower code value is reported; e.g., 8-3/4ft. is reported by code figure 5.

Note 2.

Whenever the right side of Table 6 is used (wave heights exceed 15 ft.), 50 is added to the direction code, d_wd_w. To decode subtract 50 from d_wd_w and use code figure from right side of Table 6.

Note 3.

Wave heights over 31 feet are reported by adding 50 to d_wd_w, coding H_w as 9 and following the wave group in the message with the word WAVES and the actual height of the waves in feet or meters; e.g., 16309 WAVES 33FT. Plot actual height in feet.

Each code figure in Table 6 provides for reporting a range of heights. The height shown opposite the code is generally the midpoint of the range, but since the code was originally devised in the metric system, the conversion to English units results in slight distortion of the ranges. For example: 1 = 1 to 2 ft; 4 = 6 to 7 ft; 5 = 7-1/2 to 8-1/2 ft; 7 = 10-1/2 to 12 ft; 8 = 12-1/2 to 13-1/2 ft; 9 = 14 to 15 ft.

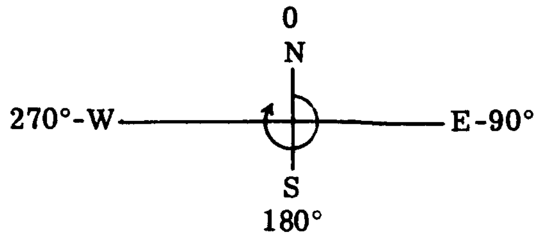
3.3.3 WIND DIRECTION AND SPEED PLOTTED AS A GUIDE. Development of the sea (height and length of waves) may be calculated from wind speed, fetch length and the duration of time the wind is blowing (3). Consequently, wind direction and wind speed are plotted on the synoptic wave chart to afford additional guidance to the analyst. The wind group (ddff) comprises the last four digits of the third group of the synoptic weather message (FM 21.C). The symbol "dd" indicates true direction in tens of degrees from which the wind is blowing, coded on the 00-36 scale of Table 4; the symbol "ff" indicates the wind speed in knots. For wind speeds of 100 to 199 knots inclusive, 50 is added to "dd". Thus, if the wind group read 05510, the plot would show a 110-knot wind from the northeast (50°) (4, 5, 7, 8).

3.3.4 SYNOPTIC WAVE CHART PLOTTING. The following plotting model is used for a synoptic wave chart:

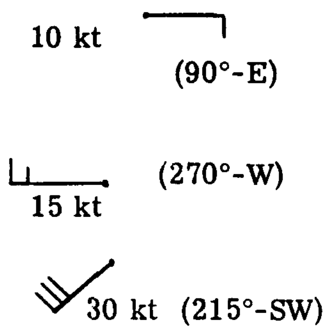
Wind (ddff)

Sea: d_wd_w	Swell: d_wd_w
P_W/H_W	P_W/H_W

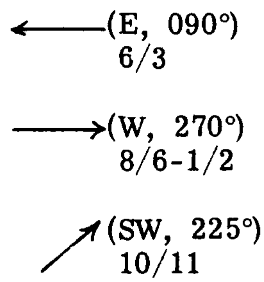
3.3.4.1 WIND DIRECTION. The wind direction is plotted on a meteorological azimuthal 360° circular plot with 0° at North and increasing clockwise.



3.3.4.2 WIND SPEED. A dot (·) locates the observation geographically. A line is drawn into the dot from the direction the wind is blowing. The speed of the wind is indicated by barbs in ten knot increments with 1/2 barbs at five knots. The barbs face clockwise, toward increasing values of direction.



3.3.4.3 SEA. The direction of the sea is plotted using an arrow for direction (commencing 0° at North and increasing clockwise). The arrow points toward the direction the sea is moving. Period and height are plotted to the right of the arrow.



3.3.4.4 SWELL. The code allows for a repeat of the wave group which shows the overriding wave train for swell. This is plotted to the right of the sea plot using an identical model (see Figure 3). The following sample messages and plots demonstrate the codes and plotting model discussed in this section. Wind, wave, and swell groups are underlined.

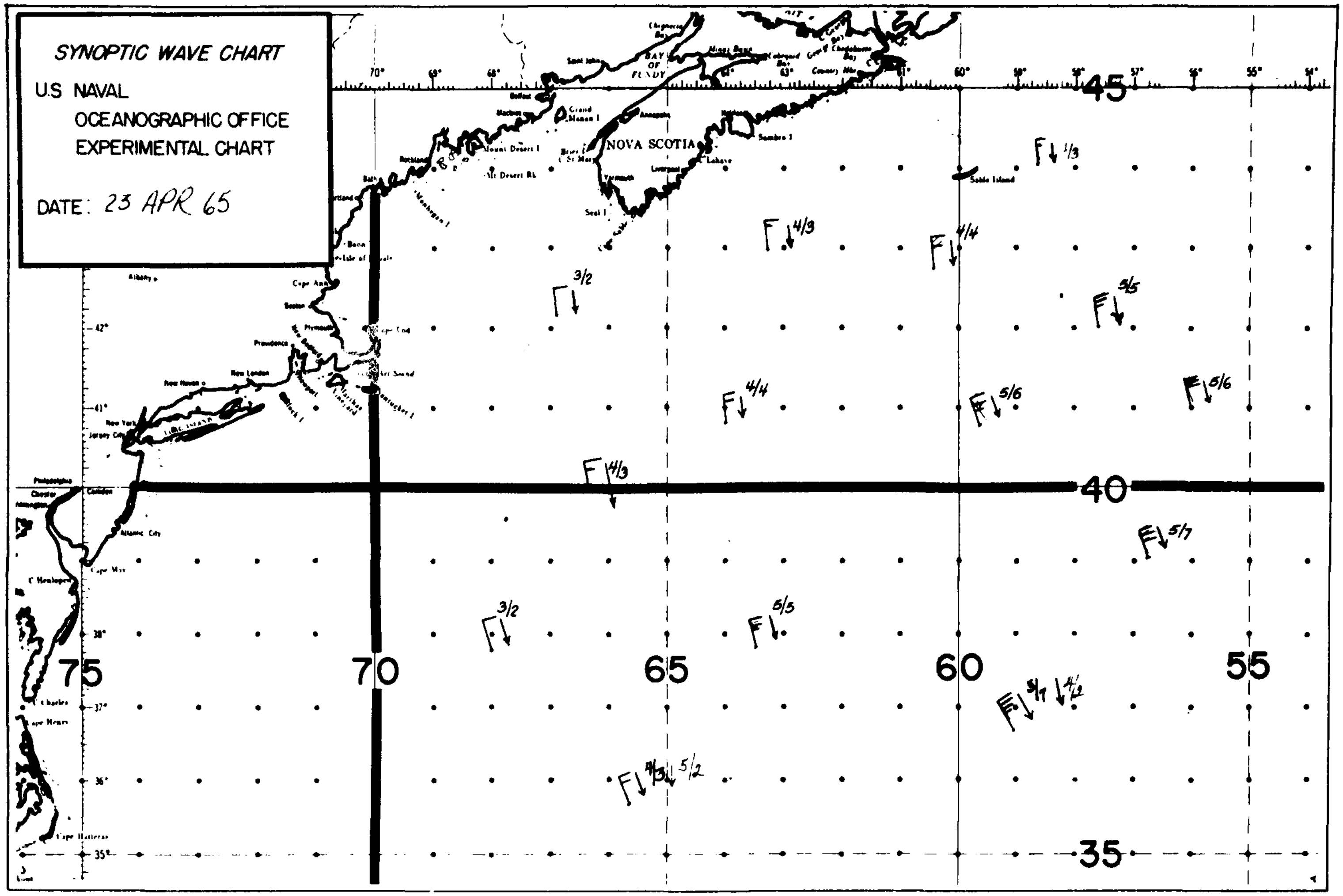
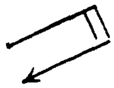


FIGURE 3

Synoptic Wave Chart

(1) SAN PABLO 60145 41412 70718 98182 14678 38479
14010 05269 10747

Wind		Sea	
Dir:	07 = 70°	Dir:	07 = 70°
Spd:	18 = 18 kts	Per:	4 = 8 sec.
		Ht:	7 = 11'

 8/11

(2) HORNET 60339 40512 20409 99020 32566 11440
15105 05144 10722 10421

Wind		Sea		Swell	
Dir:	04 = 40°	Dir:	07 = 70°	Dir:	04 = 40°
Spd:	09 = 9 kts	Per:	2 = <5 sec.	Per:	2 = <5 sec.
		Ht:	2 = 3'	Ht:	1 = 1-1/2'

 <5/3  <5/1-1/2

(3) SPRINGFIELD 60516 25811 82755 97818 99344
88XXX 64144 061XX 177X0

Wind		Sea	
Dir:	27 = 270°	Dir:	77 = 77 - 50 = 27 = 270°
Spd:	55 = 55 kts	Per:	X = undetermined
		Ht:	0 = 16'

 X/16

3.3.5 SALINITY-TEMPERATURE-DEPTH SYSTEM REPORTS AS ANOTHER SOURCE OF WAVE DATA. The wave group is optional in the OCEAN code. If reported, it appears as the fourth group in the message and is identical to the dropout wave group in the synoptic weather report (see paragraphs 2.2.,

2.4.2, and 3.3.2). The code is:

OCEAN YGGgg $QL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ $(1d_wd_wP_wH_w)$ . . .

The dropout wave group is enclosed in parentheses. Wind information is not obtained or transmitted in this code.

CHAPTER 4. PLOTTING SUBSURFACE DATA

4.1 GENERAL. Depth of the mixed layer, the rate at which temperature changes with depth, and the whereabouts and characteristics of shallow sound channels are subsurface oceanic features of great consequence to ASW operations. These particular ocean properties have a direct bearing on the effectiveness of echo ranging sonars and on torpedo behavior. Therefore an important part of oceanographic services to the ASW forces is to analyze and predict the distribution of these subsurface features. The synoptic input of subsurface data is relatively sparse, compared to that of surface data. Bathythermographs, which measure temperature as a function of depth, are the major sources. The STD sensor provides a limited routine input; also, reports may be received from survey and research vessels using reversing thermometers or more sophisticated instrumentation. Whatever the source, however, all subsurface reports are transmitted in either the BATHY or OCEAN codes.

4.2 BATHY SUMMARY CHART. A BATHY Summary Chart is prepared each day from synoptic bathythermograph (BATHY) reports. Figure 5 is an example of the chart; it consists of twenty-two reproduced BT traces and a chartlet, or key, showing the positions at which the observations were taken. Each observation is keyed to its position by number or letter; the keying indicator is placed in the upper left corner of the reproduced trace. Traces should be selected for widest geographical representation and should typify the most likely as well as the extreme conditions which might be encountered throughout the area of interest. This chart, when used with the sea surface temperature analysis, permits a quick estimate of the magnitude of environmentally affected problems which must be dealt with in the course of an ASW mission.

4.2.1 PLOTTING THE BT TRACE. The BATHY code was described in Chapter 2. Regardless of the type and/or model of bathythermograph (BT) used, all observations will be reported in this format. In the case of airborne expendable BT reports, however, 88888 will replace BATHY as the message indicator (the signal data converter cannot handle a letter prefix group) and the reference temperature group will usually be omitted. The BATHY message is designed so that the recipient can reproduce the BT trace almost exactly as it appeared on the slide. Values transmitted are the inflection points of the trace; they should be connected by straight lines (1, 6). When the surface temperature of the BT is not recorded, the reproduced trace should begin at the first reported depth. Temperature is plotted on the X-axis, depth on the Y-axis. Three typical bathythermograph reports might read as follows:

EDISTO BATHY 40530 02306 06630 XX770 00770 35770 37740
45705 52702 58675 70655 19991

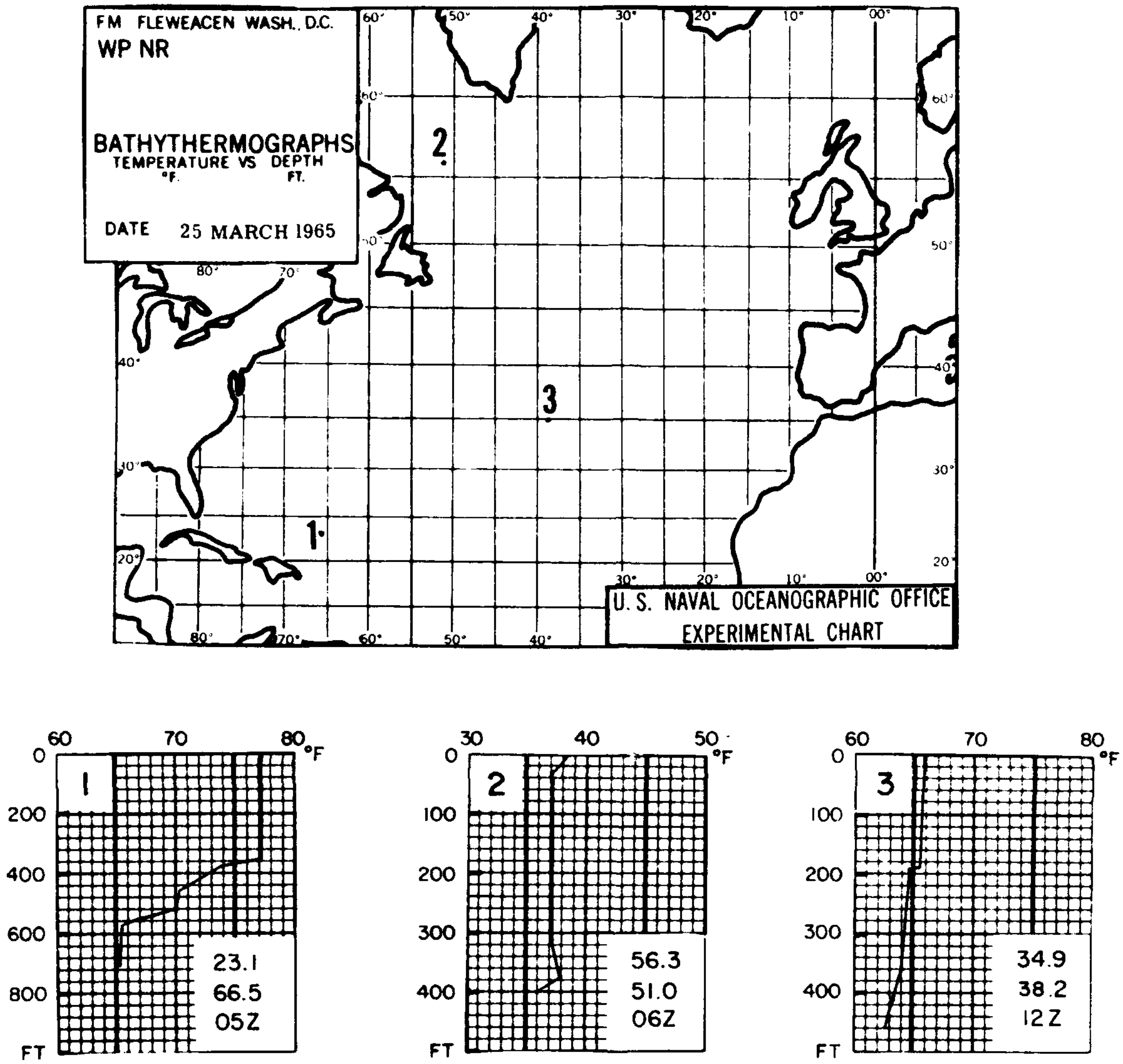


FIGURE 4

Plotted Examples of Typical Bathythermograph Traces

POINT BARROW BATHY 70600 05618 05100 99390 00382 03371 31370 38377 40356 19991

NAVY 45924 88888 11200 13454 04800 00659 19653 20645 34640 46626 19991

Figure 4 was constructed from these messages.

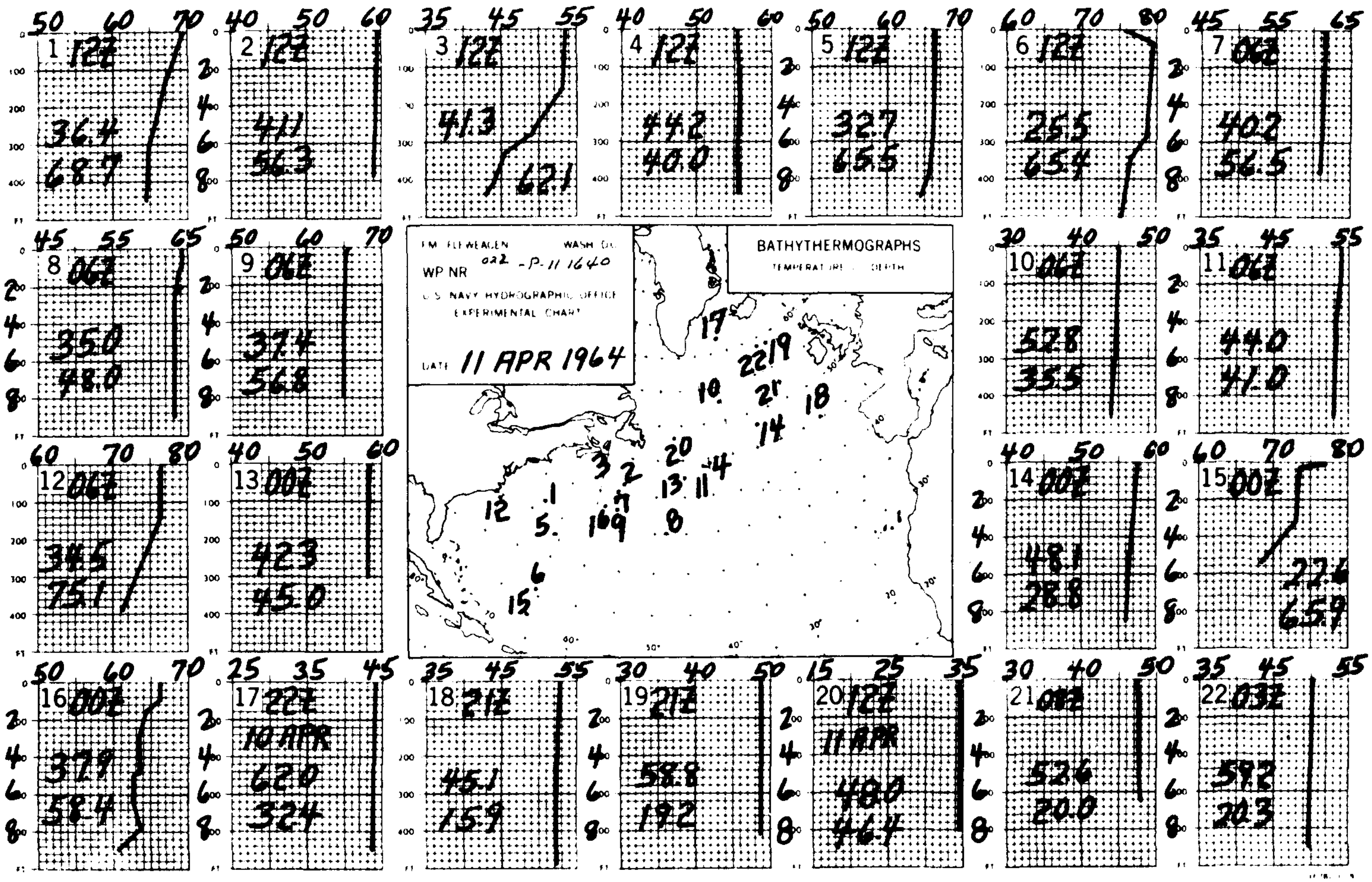


FIGURE 5

BATHY Summary Chart

4.2.2 CHECKING THE BT TRACE. Traces do not always fit a perfect model. The types of traces found will vary with the locality, the season, and the time of day. Although BT traces commonly show a decrease of temperature with depth, neither an increase of temperature with depth, nor a purely isothermal trace is unusual. Combinations of negative and positive traces, such as the zig-zag type common at the north edge of tne Gulf Stream, are also occasionally found. Comparison of questionable traces with others taken in the same general vicinity at approximately the same time is the best way to distinguish invalid traces (which are usually caused by defective instruments). All traces should be carefully screened, compared with other typical traces, and discarded if too great a discrepancy exists. The keying indicator is underlined once in the key chartlet if questionable traces are included in the summary chart.

4.2.3 MESSAGE ERRORS. Errors common to the first five groups of the BATHY message (through the surface temperature) are discussed in Chapter 3. The following errors occur at times in the balance of the message.

4.2.3.1 REVERSAL OF DEPTH AND TEMPERATURE. When this type of error is made, it is usually consistent for the entire message and quickly spotted. Visual inspection is usually sufficient to correct the values for plotting.

4.2.3.2 DEPTH INDICATOR OUT OF SEQUENCE. In most cases where depths appear to be out of sequence, the error is attributable to transmission garbles. Sometimes the depth digits are reversed; for example, temperature at 500 feet is received as 05699 instead of 50699. The correct depth can often be ascertained by inspecting the trace and comparing the questionable data point with the values above and beneath it.

4.2.3.3 REPORTING DEPTH IMPROPERLY. Occasionally BT temperatures are reported at constant depth intervals (0', 50', 100', 150', etc.). At times, oceanographic station "standard depths" may be used. Standard depths (0, 10, 20, 30, 50, 75, 100, 150, 200, etc.) are almost always in meters and would only be received in the OCEAN code. This manner of reporting precludes a valid reconstruction of the temperature trace, since the actual inflection points which should have been reported may lie somewhere between the given depths. Despite this drawback, the data will give a general idea of the temperature structure, and are still of value. When no better reports are available for the BT Summary Chart, the trace can and should be used, but ought to be marked with an asterisk (*) under the indicator in the key block to indicate possibly misleading data.

4.2.3.4 READING ERRORS IN EVEN INCREMENTS OF 5° and 10°. Temperatures are sometimes read and reported 5 or 10 degrees off the actual

value. Such errors are generally confined to one or two values only. When the trace is plotted, these radical or sudden departures from a smooth trace are immediately obvious and can be corrected. The indicator in the key block should be underlined twice to indicate that the trace contains corrected data.

4.2.3.5 READING ERRORS OF ONE VALUE. A single radical temperature departure from a rather smooth trace can be adjusted to the proper value by fitting the erratic point to the slope of the curve; that is, place the point on a straight line drawn from the point just above the anomalous value to the next point below it. Underline the key indicator twice.

4.3 SONIC LAYER DEPTH CHARTS. The sonic layer depth (SLD) chart provides information basic to the determination of sound propagation in the upper layers of the ocean. Sonic layer depth is defined as the depth of maximum sound velocity in the upper 1000 feet of the water column and is obtained from the synoptic bathythermograph (BATHY) messages. Sound velocity increases with increasing temperature, salinity and pressure (depth), but since salinity varies little in the open ocean, its effect is usually disregarded. Sonic layer depth charts are prepared at Regional Analysis Centers and distributed to the Fleet via facsimile approximately twice a week.

4.3.1 DETERMINING THE SLD. The following rules should be followed in determining SLD from the BATHY messages.

(1) Any change from the surface to 15 feet may be disregarded.

(2) SLD is that depth at which a negative gradient becomes more negative than 0.3°F per 100 feet (with surface water temperatures below 35°F use 0.2°F per 100 feet; above 85°F use 0.4°F per 100 feet).

(3) SLD is the depth of maximum temperature:

(a) if maximum temperature occurs at more than one depth, SLD is the greatest depth at which it occurs.

(b) if a single maximum temperature occurs at 15 feet and the gradient exceeds the criterion given above for negative gradients, SLD is zero.

For the BATHY's of Section 4.2.1 and Figure 5, the respective SLD's are: EDISTO, 350 feet; POINT BARROW, 380 feet; NAVY 45924, 0 feet.

4.3.2 PLOTTING THE SONIC LAYER DEPTH CHART. The depth of the sonic layer is plotted on a composite chart similar to the sea surface temperature chart. In this case also, plots are prepared on an overlapping basis for predetermined periods. Table 7 describes the color code used for this composite chart, of which Figure 6 is an example. Each observation is located geographically with the day symbol. The layer depth is plotted to the right of the day symbol. To aid analysis, the reference temperature is plotted

TABLE 7

10-Day Composite Chart Plotting Code for Sonic Layer Depth Chart

Day	Symbol	Color	Layer Depth (Ft.)
1st through 5th	·	Blue	0- 99
6th	-	Red	100-199
7th	Δ	Black	200-299
8th	∇	Green	300-399
9th	+	Purple	400 and below
10th	X		

in whole degrees and tenths to the left of the day symbol. A boxed temperature, $\boxed{70.7}$, indicates that the difference between the reference temperature and the BT surface temperature is more than 2.5°F (1.5°C). Only the tens digit of the layer depth is plotted, since the color identifies the hundreds digit. The units digit is not plotted as the chart is contoured only to 100-foot intervals. Zero depth is plotted as "0" in blue. When values exceed 499 feet, both the hundreds and tens digits are plotted in purple. A plus sign "+", following the plotted layer depth indicates that the layer depth is greater than the value given. The figure recorded is the depth of the trace obtained.

Assuming the first day of the layer depth chart corresponds to the first day of the week and the BT traces are recorded in chronological order, the three examples of the previous section (4.2.1) are plotted as follows:

(1) EDISTO: Wednesday (Y = 4) ·5 Green

(2) POINT BARROW: Saturday (Y = 7) Δ8 Green

(3) NAVY 45924: Sunday (Y = 1) ∇0 Blue

4.3.3 ADDING THE NEAR-SURFACE GRADIENT. Near-surface gradient information is added to the SLD plot whenever:

(1) SLD is zero.

(2) The temperature difference between the SLD and the surface is positive.

4.3.3.1 NEGATIVE GRADIENTS. When SLD is zero, the analyst uses gradient information to estimate the likelihood that the condition will persist. Weak negative gradients at or near the surface are usually transitory, and disappear when the water cools at night or the wind increases slightly. Strong negative gradients indicate a more persistent condition, since fairly strong winds are required to mix the water. The strength of the gradient is expressed in degrees Fahrenheit per 100 feet and is computed as follows:

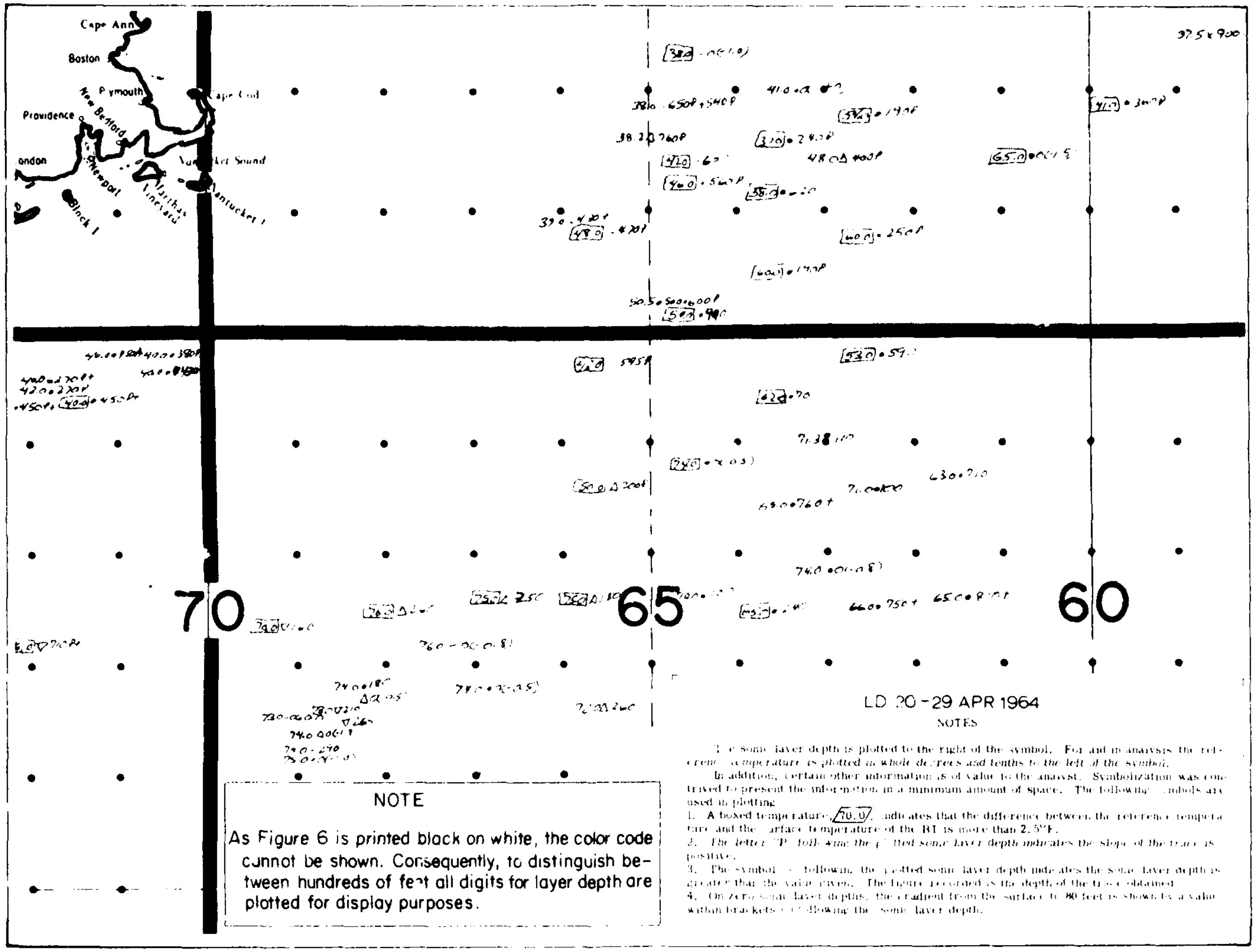


FIGURE 6

Plotted Sonic Layer Depth Chart

(1) If the gradient is constant to at least 100 feet, subtract the surface temperature from the 100-foot temperature.

(2) If the gradient is constant to some depth which is less than 100 feet, subtract the surface temperature from the temperature at the bottom of the gradient. Multiply this difference by 100 divided by the depth of the maximum temperature.

Example:	T at 80'	=	68°
	T at 0'	=	72°
	Difference	=	-4°

$$-4° \times \frac{100}{80} = -5° \text{ (gradient in °F/100 ft.)}$$

The gradient is plotted to the right of the SLD and enclosed in parentheses. The minus sign can be omitted. Thus, the point ∇0(2) plotted on a composite SLD chart would mean that a zero layer with gradient strength of -2°F per 100 feet was observed at that position on the eighth day of the composite period.

4.3.3.2 POSITIVE GRADIENTS. When temperature increases from the surface to the SLD, a positive in-layer gradient exists. This condition is indicated on the SLD plot by following the SLD value with the letter "P". The strength of the gradient is not computed in this case. Areas of positive in-layer gradients are noted on the charts issued to the operating forces, to alert them that sonar ranges will be less than predicted for an isothermal layer of the same thickness.

4.4 VERTICAL TEMPERATURE GRADIENT CHARTS. Although sea surface temperature and sonic layer depth charts present basic data for computing hull-mounted sonar ranges, additional and/or more precise determinations require knowledge of the thermal gradients in the water column as well. Analyzed plots of the temperature difference between the surface and 80 feet, 280 to 400 feet, or between other levels as may be specified by the analyst are issued to provide this information. The gradient is plotted on a base (or overlay) similar to the layer depth base chart on an overlapping basis in predetermined time intervals. The day symbol is used to position each observation and the temperature difference is plotted in degrees and tenths. The data are obtained from the BT traces by subtracting the temperature at the upper level from that at the lower level. If, for example, the analysis were to show gradients between 200 and 300 feet, the 200-foot temperatures would be subtracted from the 300-foot values. When the difference is negative, as is usually the case, the number is plotted with no sign. Positive gradient values are prefixed with a plus sign when plotted; e.g., +4.2.

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GLOSSARY

1. Airborne Expendable Bathythermograph (AXBT) An instrument operated from aircraft to measure temperature continuously to 500 feet. The expendable unit comprises a sonobuoy with inset thermistor probe which free-falls upon impact with the water; signals are converted and read out on an analog recorder aboard the aircraft.

2. Airborne Radiation Thermometer (ART) An infrared-sensing device which measures the sea surface temperature from an aircraft.

3. Bathythermogram The record of temperature and depth obtained with a *bathythermograph.*

4. Bathythermograph (BT) A shipboard device for obtaining a record of temperature versus depth. The thermal element is a xylene-filled copper coil which activates a stylus through a Bourdon tube. The pressure element is a copper aneroid capsule which moves a coated glass slide up and down at right angles to the motion of the stylus. A double analog record called a bathythermogram is thus obtained as the BT is lowered and recovered.

5. Bathythermograph Grid A glass slide on which is permanently recorded a calibration scale of temperature versus depth values for each bathythermograph. A new grid is made each time the instrument is calibrated. Temperature/depth values are read from the BT slide by inserting it in a slide holder against the grid.

6. Bathythermograph Slide A 1-inch by 1-3/4-inch glass slide with a coated surface on one side (gold anodized). A stylus on

the bathythermograph scratches a depth versus temperature trace on the coated surface.

7. Bucket Temperature The surface temperature of the sea as measured by a bucket thermometer or by immersing a thermometer in a freshly drawn bucket of water from the sea surface.

8. Bucket Thermometer A thermometer mounted on a wooden frame so that the bulb is immersed in a cup at the base. When the frame is lowered into the water, the cup fills and the surface temperature can be read directly.

9. Composite Chart A chart based on data for extended periods, usually 5 to 10 days, treated as being synoptic.

10. End-of-Message Indicator A group of digits or letters which signifies completion of a coded message. 19991 is used commonly in oceanographic data transmissions. Also termed "Automated Processing Terminator".

11. Facsimile The transmission and reproduction of printed matter by a process involving the use of radio broadcast. The transmitted signals, formed by a photoelectric cell that picks up the differences in light and dark in the subject matter as it is scanned by a beam of light, are converted into a facsimile of the original matter by a mechanism attached to the radio receiver.

12. Gradient The rate of change of one quantity with respect to another, as the rate of decrease of temperature with depth in the thermocline.

13. Greenwich Mean Time The mean solar time as the sun crosses the meridian at Greenwich, England, used as a basis for standard time throughout much of the world.

14. Injection Temperature The temperature of the sea water as measured at sea water intakes in the engine room of a vessel.

15. Injection Thermistor A thermistor that is installed in the ship's sea water injection intake pipe to measure the sea water temperature.

16. Isothermal A condition of equal or constant temperature.

17. Letter Prefix Group The letters which prefix the coded message, such as BATHY or ARTST.

18. Negative Gradient The decrease of temperature as the depth increases.

19. Parameters In general, any dependent variable in a problem. The term is also used for quantities to which arbitrary values can be assigned for the problem at hand.

20. Period of waves The time between the passage of two successive crests through a fixed point.

21. Positive Gradient The increase of temperature as the depth increases.

22. Plotting Symbol A special symbol or color used to code data plotted on a single chart base.

23. Reference Temperature The sea surface temperature measured with a bucket thermometer or similar device and used to check the calibration of another instrument. Reference temperature is recorded in degrees and tenths and reported as a separate entry.

24. Salinity A measure of the quantity of dissolved salts in sea water.

25. Salinity-Temperature-Depth Sensor (STD) This sensor measures temperature and salinity as functions of depth.

26. Sea State The numerical or written description of ocean surface roughness. For more precise usage, sea state is the average height of the highest one-third of the waves observed in a wave train, numerically coded in accord with the increasing range of heights.

27. Sea Surface Temperature (SST) The temperature of the layer of sea water nearest the atmosphere. It is generally determined either by bucket or injection thermometers.

28. Shipboard Expendable Bathythermograph (SXBT) An instrument system comprised of a launcher, recorder, and expendable probes, designed to measure

water temperature with depth to 1500 feet from a ship moving at speeds up to 25 knots, in seas up to 20 feet.

29. Sonic Layer Depth (SLD) The depth of maximum sound velocity in the top 1000 feet of the ocean. Energy from a near-surface sound source is trapped between the surface and SLD by upward refraction.

30. Standard Depth The depth below the sea surface at which water properties are measured and reported, either directly or by interpolation, according to the proposal by the International Association of Physical Oceanography in 1936. The accepted depths (in meters) are: 0, 10, 20, 30, 50, 75, 100, 150, 200, 300, 400, 500, 600, 800, 1000, 1200, 1500, 2000, 2500, 3000, 4000, 5000, 6000, 7000, 8000, 9000, 10000, to which NODC has added 1250 and 1750 meters.

31. Synoptic Chart An analyzed chart showing the distribution of a meteorological or oceanographic property observed in various places over a wide region at or near the same time.

32. Thermistor An electric resistor made of a material whose resistance varies sharply in a known manner with the temperature.

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Paragraph

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